

MAE 212
Spring 2001

HW 3

Due Thursday, February 15

1. Common aluminum foil for household use is nearly pure aluminum (density $\rho = 2.70 \cdot 10^6 \text{ g/m}^3$). A box of this product at a local supermarket is advertised as giving 75 ft^2 of material (in a roll 304 mm wide by 22.8 m long). If a foil is 0.5 mil (12.7 μm) thick, calculate the number of atoms of aluminum in the roll (Problem 2.2 from the text)
2. Naturally occurring copper has an atomic weight of 63.55. Its principal isotopes are Cu^{63} and Cu^{65} . What is the abundance (in atomic percent) of each isotope? (Problem 2.8 from the text)
3. The outside layers of the quarter coin consist of an alloy of 75 wt% copper and 25 wt% nickel. What are the atomic percent Cu and atomic percent Ni contents of this material?
4. Calculate the coulombic attractive force between a pair of Na^+ and Cl^- ions that just touch each other. Assume the ionic radius of the Na^+ ion to be 0.095 nm and that of the Cl^- to be 0.181 nm. (Use Coulomb's law $F_{\text{attractive}} = -\frac{(Z_1e)(Z_2e)}{4\pi\epsilon_0r^2} = -\frac{Z_1Z_2e^2}{4\pi\epsilon_0r^2}$, where Z_i is the valence of the charged ion (e.g. +1 for Na^+ and -1 for Cl^-), $\epsilon_0 = 8.85 \cdot 10^{-12} \text{ C}^2/(\text{N m}^2)$ is the permittivity of free space, r the interionic separation distance and e the electron charge ($1.6 \cdot 10^{-19} \text{ C}$)).
5. Calculate the net potential energy of a simple Na^+Cl^- ion pair by using the equation:

$$E_{\text{net}} = \frac{Z_1Z_2e^2}{4\pi\epsilon_0r} + \frac{b}{r^n}$$

by using the b value obtained from the repulsive force calculated for the Na^+Cl^- ion pair in the previous problem. Assume $n=9$ for NaCl .

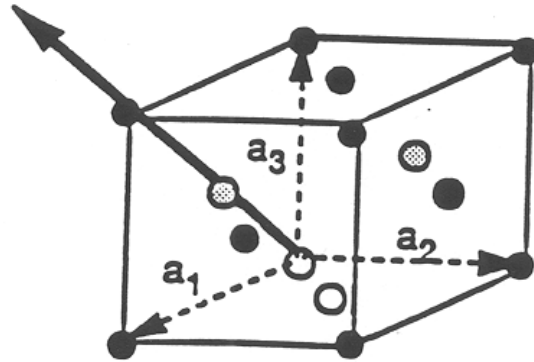
6. The potential energy U of two atoms, a distance r apart, is

$$U = -\frac{A}{r^m} + \frac{B}{r^n}, \quad m = 2, \quad n = 10 \quad (1)$$

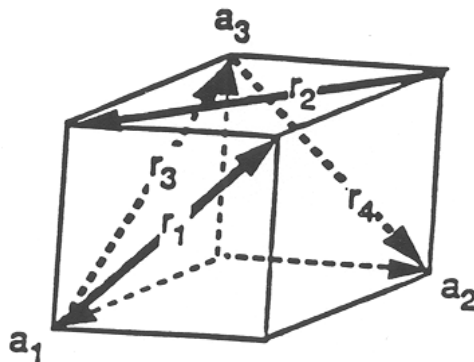
Given that the atoms form a stable molecule at a separation of 0.4 nm with an energy of -5 eV , calculate A and B . Also find the force required to break the molecule, and the critical separation at which the molecule breaks. You should sketch an energy/distance

curve for the atom, and sketch beneath this curve the appropriate force/distance curve (see lecture 5).

7. Identify the axial intercepts for the $(3\bar{1}1)$ plane (Sample problem 3.12 of the text).
8. In the fcc unit cell, what are the Miller indices of the vector describing the direction of the face diagonal? (from lecture notes)



9. What are the Miller indices of the vectors r_1 , r_2 , r_3 and r_4 in the Fig. below? If the cube represents the unit cell of an fcc crystal, show the arrangement of atoms along each direction (from lecture notes).



10. List the family of the $\{110\}$ planes in the cubic system.
11. (a) Sketch in a cubic unit cell a $[111]$ and a $[112]$ lattice direction (b) Determine the angle between these two directions (Problem 3.28 from the Text)
12. What $[hkl]$ direction connects the adjacent face centered positions $\frac{1}{2}\frac{1}{2}0$ and $\frac{1}{2}0\frac{1}{2}$? Illustrate your answer with a sketch (Problem 3.34 from the Text).
13. Determine which members of the $\langle 110 \rangle$ family of directions lie within the (111) plane (Problem 3.35 from the Text).